

Influence of Economic Crisis on Application of EMS Criterion in Selection of Logistic Service Providers

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ABSTRACT

The aim of the paper consists in answering the question whether providers of logistic services can benefit from implementing and maintaining an environmental management system (EMS), especially with regard to intensified competition pressure in time of macroeconomic crisis. It is hypothesized there may exist data indicating that the economic crisis of 2008-2009 influenced whether businesses – as a criterion applied in the framework of their supplier selection process – consider the fact whether their potential provider of logistic services has EMS (Environment Management System) implemented in its organizational structure. The analysis comprises a sample of 293 companies pursuing their entrepreneurial entities in the Czech Republic. Based on testing the difference between 2 proportions of the EMS criterion application, the research compares the situation in the year closely preceding (2006) and following (2010) the crisis. The analysis not only regards the examined sample of the companies as a homogenous statistical selection, but also as a heterogeneous one, which means that the originally homogenous company sample is divided into 6 disjunctive subgroups (strata) based on the number of the company employees. The stratification makes it possible to carry out a yet more detailed analysis of the detected differences in the EMS criterion application. The aim of the paper is not to speculate about the differences ascertained, but identify and describe them in a systematic and statistical exact manner.

Keywords: EMS, environmental management, logistic services, provider selection, economic crisis

JEL Classification: D22, Q56.

INTRODUCTION

The importance of finding ways to ensure sustainable development and thus environmental protection is understood by many organizations, not only in the non-profit sector, where it could naturally be expected, but this trend is beginning to manifest itself also in the for-profit sector (i.e. in the corporate sector) (Nenadál, 2002). Special attention is paid to waste materials and other chemicals, especially if they have a defined property that is dangerous for objects, living beings or people in their vicinity (they are infectious, toxic, explosive, highly flammable, etc.) (Veber, 2010). In order to ensure environmental protection and sustainable development, a series of standards and regulations have been created and are currently applied, and a number of certifications have been issued on their basis, aimed at protecting people, fauna, flora and the environment as a whole. In accordance with these standards, certified systems, the mission of which is to ensure environmental protection, EMS (Environment Management System) systems are increasingly being introduced (Stevens, 2012). Every company, whether acting as a goods supplier/service provider or a customer in a market environment, needs a consistent information system to perform its activities, which takes not only economic factors but also environmental aspects (Cobut, 2013) into account. EMS systems thus become an essential tool to support the implementation of in-house decision-making processes, further development and improvement of these processes

and thus represent an important component of corporate management, which permeate all internal organizational processes (Suchánek, 2005). As the primary precondition for the existence of any business entity is the fact that it achieves economic profit, it is essential that the standards for the implementation of EMS can be reconciled with the legitimate interests of businesses and that these include not only environmental objectives, but also economic goals. In particular, it is not permissible for these standards to become an obstacle to free trade (in the form of an "international barrier") or impose additional legal obligations on traders (Suchánek, 2005).

It is necessary that the rules incorporated in these standards regulate the behavior of employees in managerial positions, within their decision-making powers (Veber, 2002). The degree of integration of the environmental aspect can then represent a significant competitive advantage for the company, which can then significantly affect not only its economic results, but - in times of economic turbulence - be crucial for its economic "survival". It is therefore recommendable to integrate the environmental aspect into the internal decision-making processes that the company applies in the selection of external suppliers so that the company can benefit through an "improved" image in the eyes of its potential customers ensuing from the mere fact that its suppliers have EMS system implemented (Orálek,

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2006). Thus, it can be expected that it is just in times of economic crisis that the pressure for integration in the above sense intensifies under the pressure of competition, which consequently also leads to an increased number of companies which – in some form – implement the EMS system as suppliers.

1. Formulation of the problem

The research examines whether logistic services providers can benefit from implementing and/or maintaining EMS. First, the situation in this respect will be analyzed in the period of the 2008-2009 economic crisis. Among others, it will be ascertained whether there exist data indicating that the economic crisis of 2008-2009 affected the manner in which companies pursuing their business activities in the Czech Republic – within the framework of their provider selection process – consider the fact whether the potential provider has an EMS implemented in its internal structures (hereinafter "whether the companies apply the EMS criterion"). The following basic hypothesis was formulated:

The rate of the criterion application in 2006 was different from that in 2010.

Then, the conclusions derived from the above analysis of the 2008-2009 crisis will analogically be transferred into the present corona virus economic recession of 2020. Based on this, recommendations for logistic service providers will be elaborated with the aim to improve their competitive position and increase their chances of being successful in the provider selection process carried out by their potential business customers.

2. Methodology

2.1. Respondent selection

The "Albertina Company Database - Company Monitor" was used to select the contacted companies (potential respondents). In order to ensure sufficient representativeness, the selection was realized using the internal search tool of the above database so that it contains only entities that meet the following criteria:

- They are legal persons (entities with the status of a natural person have therefore been excluded, however the legal form of activity was disregarded)
- Their main goal consists in generating profit (entities of entrepreneurial nature – businesses, exclusively).
- The character of their entrepreneurial activities consists in producing goods (not providing services so that using of external logistic services can be expected)
- They pursued their activities in the both examined periods, i.e. in the year 2006 as well as 2010 (therefore the businesses that did not exist in one of the examined periods were excluded).
- Their registered office in the Czech Republic, regardless of the regional aspect (with the aim to ensure mutual comparability of respondents' statistical samples based on the same macroeconomic environment, which may differ significantly in the case of different state units.
- They have the maximum of 300 employees (therefore, the entities whose inclusion in the statistical analysis

could distort its results and whose number is statistically negligible were excluded).

The sample created according to the above criteria comprised 366 companies.

2.2. Questions asked

Each respondent in the company sample as specified above was asked 2 questions (Questions 1/2) communicated in the form of a telephone survey, which was chosen with a view of ensuring a sufficient information yield of potential respondents:

"In 2006/2010, did your company – in its provider selection process – apply the criterion whether the potential provider has an EMS implemented?"

For each of the above questions, the respondents had a choice of 2 response alternatives (i.e. 2 alternatives related to applying the criterion), namely: No / Yes.

2.3. Statistical instruments applied

The selection of a statistical instrument (test/procedure) for hypothesis verification, or a whole set of these instruments (see the principle of statistical multi-instrumentality below) is determined by the relationship between the compared statistical samples (year-on-year application of the EMS criterion), which is based on the overall design of the data analysis. In this case, the design consists in a comparison of 2 dependent binomial proportions. This is because the proportions of the EMS criterion application are compared across 2 statistical samples (the year 2006 versus 2010), which are (mutually) dependent / paired / correlated (as they comprise the same companies), and the application proportions are expressed by a binomial categorical variable (i.e. the variable can take exactly 2 values: Yes / No).

Fig.1 gives the list of the instruments (tests/procedures) applied, divided according to the stage of the analysis, i.e. basic (ignoring the company size) versus post-hoc (stratification by company size).

In order to attain sufficient validity, and thus the reliability of conclusions based on the verification of the hypotheses, the principle of statistical multi-instrumentality was applied. This means that several tests are applied to verify one hypothesis because these may provide (slightly) different results or the opinion on their reliability and possibilities of their application may differ among experts. For this reason, the tests include both the asymptotic (approximate) tests, which require a higher frequency of analyzed samples, and the exact tests, which can work with selections with significantly lower frequencies, and possibly also the asymptotic tests with continuity correction, which are a kind of compromise between the two types given above. This multi-instrumental approach is very suitable especially in cases where the test results are marginal and do not allow conclusions to be drawn with satisfactory reliability.

All the tests and procedures were performed on the 2-sides basis and at the standard level of statistical significance $\alpha = 0.05$.

Fig 1 Statistical in struments applied

		INTER-SAMPLE CORRELATION		
		TYPE	DEPENDENT SAMPLES	INDEPENDENT SAMPLES
ANALYSIS STAGE	BASIC	Difference of proportions	<ul style="list-style-type: none">• McNemartest (Fleiss, Levin, & Paik, 2003; Liu, Hsueh, Hsieh, & Chen, 2002)• Wald Z test	<i>Not applicable</i>
		Ratio of proportions	<ul style="list-style-type: none">• Nam score test(Nam, 1997)	<i>Not applicable</i>
		Odds Ratio of proportions		<i>Not applicable</i>
	POST-HOC (stratification)	Test of independence within strata	<ul style="list-style-type: none">• Fisher exact test for 2x2 tables(Fisher, 1922)	<i>Not applicable</i>
		Repeated independence test for 2x2 table	<ul style="list-style-type: none">• Homogeneity test of odds ratios(Schlesselman & Stolley, 1982)• Cochran-Mantel-Haenszel test with continuity correction• Cochran-Mantel-Haenszel test (CMH) (Mantel & Haenszel, 1959)• Robinson test [-]• Woolf test (Schlesselman & Stolley, 1982)	<i>Not applicable</i>

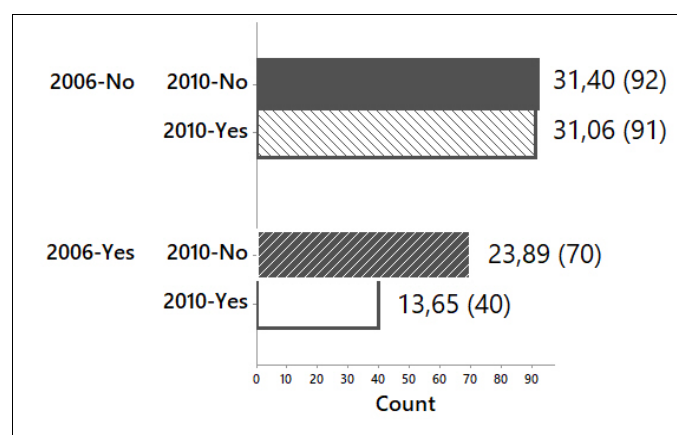
Source: own

3. Analysis of the problem

3.1. Data ascertained

The proportions of the EMS criterion application is compared between 2 statistical samples (the years 2006 versus 2010), containing the identical companies (which pursued their activities in both the years compared and provided data on them), while each of these companies (respondents) had a choice only of 2 alternatives for applying the criterion (No versus Yes).

The required data (as specified in the methodology section) was provided (and external logistic services were used) by 293 respondents (80.05% of the total number of 366 companies contacted as specified in the respondent selection section). There was a slight year-on-year increase in the application of the criterion, from 110 companies (37.54% of the total number of 293 respondents) (2006) to 131 (44.71%) (2010). Fig.2, which contingently captures the structure of the changes observed, shows that 92 (31.40%) companies did not apply the criterion in either 2006 or 2010, and 40 (13.65%) companies applied it in both years, so the total number of companies for which no year-on-year change was detected and which are therefore neutral in terms of the result of the following statistical test is 132 (45.05%). 70 (23.89%) companies ceased to apply the criterion in 2010, but 91 (31.06%) companies, which means 21 (7.17%) more, started to apply it in 2010, so that the total number of companies for which a year-on-year change was detected and which are therefore not neutral in terms of the result of the following statistical test, amounts to 161 (54.95%). The overall balance of these contrariwise movements is therefore in favor of a shift in the direction from the No alternative to the Yes alternative, in which also consists the asymmetry of the contingency table. This asymmetry will be analyzed as part of the hypothesis verification.

Fig 2 Criterion application – Contingency

Count: % of the respondents in year (absolute count is given in brackets)

Source: own

3.2. Basic tests

In order to comprehensively and reliably verify the basic hypothesis, 2 auxiliary hypotheses were formulated and tested – each of them conceives the concept of equality of the application proportions in a fundamentally different manner (which may potentially lead to diametrically different results):

➤ H_0 : "The difference between the criterion application proportion in 2006 and that in 2010 is equal to 0 ($P_{2006} - P_{2010} = 0$)"

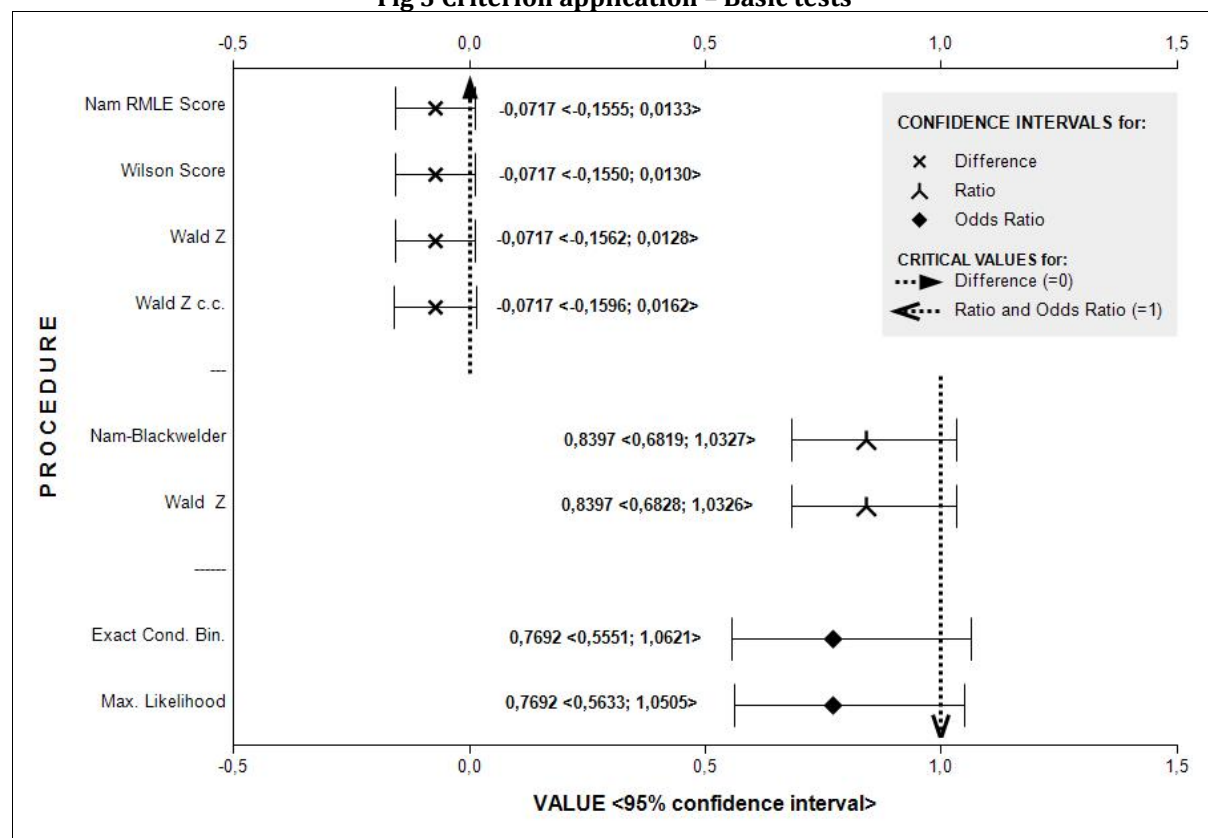
This tests the difference (obtained by subtracting) of the application proportions, using McNemar test and Wald Z test.

➤ H_0 : "The ratio of the criterion application proportion in 2006 and that in 2010 is equal to 1 ($P_{2006} / P_{2010} = 1$)"

This tests the ratio (obtained by dividing) of the application proportions, using Nam Score test.

On the base of the paired test for table 2x2, neither of these auxiliary hypotheses was rejected (McNemar test [resulting p-value: 0.0979]; Wald Z test [0.1045]; Nam Score test [0.0979]), which means that neither the difference in the criterion application proportions nor their ratio is statistically significant, which are two different facts that may not always be mutually compatible. This conclusion is confirmed by the confidence intervals (Fig. 3), which were determined not only for both the aspects tested above (the difference obtained by subtraction of the proportions, and also the ratio of the proportions), but also for the odds ratio of the proportions. Given the above facts, we can state with a very high degree of evidence that the observed difference in the degree of application of the EMS criterion between 2006 and 2010 is not statistically significant and the basic hypothesis was not verified.

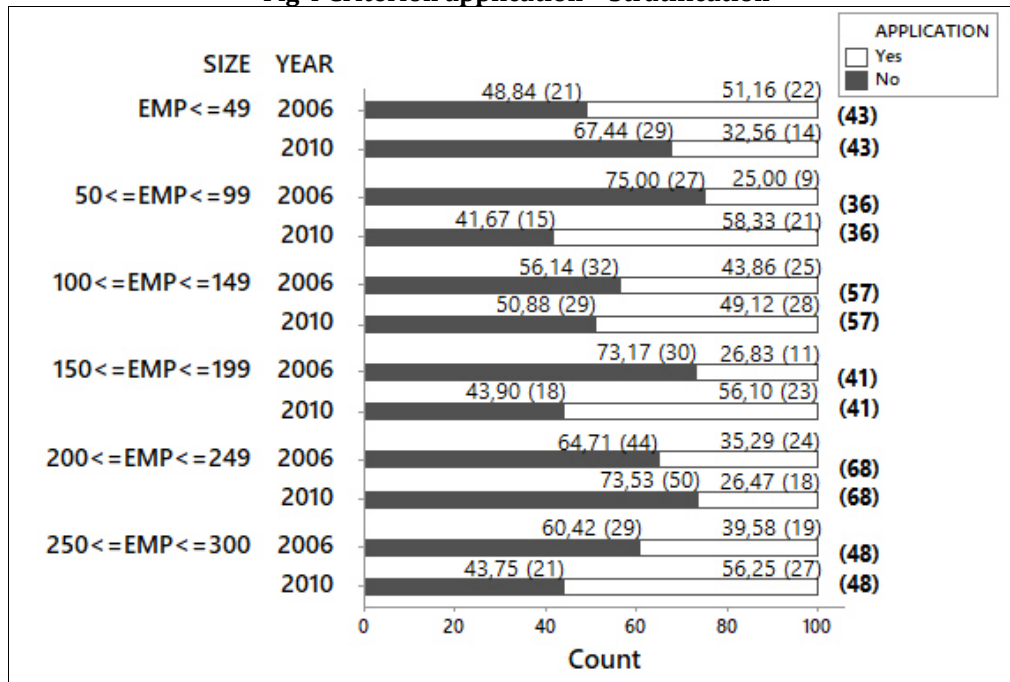
Fig 3 Criterion application – Basic tests



Source: own

Post-hoc tests(Stratification)– Test of independence within strata

The originally homogeneous statistical sample of 293 companies (respondents) was – based on the criterion of the number of employees stratified –into 6 disjunctive categories of company size. The sizes of each category (stratum) and the proportion of the EMS criterion application within each layer are shown in Fig. 4.

Fig 4 Criterion application – Stratification

Count: % of the respondents in year (absolute count is given in brackets)

Source: own

First, the value of the odds of the criterion application was calculated for each year (i.e. both 2006 and 2010) in each individual company size category (Fig. 5), according to the formula $O_{YR} = \frac{P_{YR}}{1 - P_{YR}}$, where P_{YR} represents the (by a decimal number expressed)

probability of the criterion application in the respective year and in the respective company size category. The fact that the odds reach the highest value ($RP_{CAT} = 1.4000$) in the size category of $50 \leq EMP \leq 99$ in the year 2010 supports the conclusion that the EMS criterion was most frequently applied by the companies of just this size and just in this year. On the contrary, the odds are the lowest ($RP_{CAT} = 0.3333$) in the size category of $50 \leq EMP \leq 99$ in the year 2010, which means that the EMS criterion application was the lowest with the companies of this size and in this year.

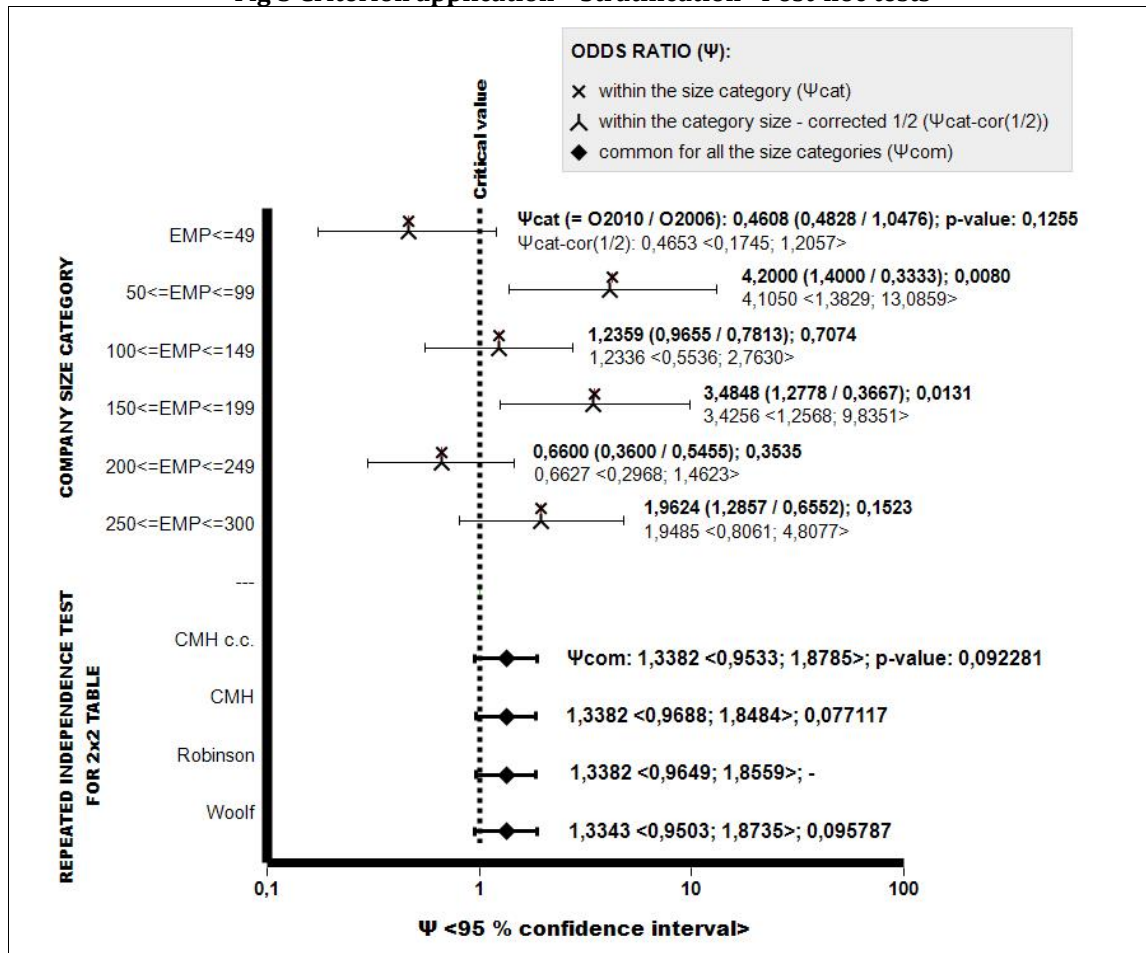
In the next step, the odds ratio of criterion application was calculated for each individual company size category (Fig. 5), according to the formula $\psi_{CAT} = \frac{O_i}{O_j}$, where O represents the (by a decimal number expressed) odds ratio in the respective size

category. Subsequently, the auxiliary hypothesis H_0 was formulated: "The odds ratio of the criterion application within the given company size category is equal to 1" ($\psi_{CAT} = 1$), which is analogous to the hypothesis: H_0 : "The categorical variable 'year' and the categorical variable 'criterion application' are independent within the respective company size category". Using the test of independence within strata this hypothesis was tested in each company size category, but rejected only within categories of $50 \leq EMP \leq 99$ [p-value: 0.0080] and $150 \leq EMP \leq 199$ [0.0131], which is also confirmed by confidence intervals determined for the corrected odds ratios (Fig. 5). It can therefore be stated that- although a statistically significant year-on-year difference in the criterion application could not be detected in the basic test ignoring the company size - a difference was detected "separately" within the 2 above company size categories (but not within the other categories). Another ascertainment ensues from a mutual comparison of the values of the calculated odds ratios (ψ_{CAT}) between the individual strata. The fact that the odds ratio reaches the highest value in the stratum of $50 \leq EMP \leq 99$ ($\psi_{CAT} = 4.2000$) suggests that the highest increase in the EMS criterion application occurred just in the named company size category.

3.3. Post-hoc tests (Stratification)- Repeated independence test for 2x2table

The core of stratification analysis consists in the repeated independence test for 2x2table. However, first the homogeneity (equality) the odd ratios of the criterion application (ψ_{CAT}) across all the strata must be tested, which ascertains whether there exists a (for all the strata) common odds ratio (ψ_{COM}). As the next step - provided such a common odds ratio does exist - the follow-up repeated independence test for 2x2table verifies whether the common odds ratio is equal to 1. If it is, it means that the difference in the criterion application detected in the basic test consists only in the variability across the company size categories (strata), rather than in the variability between the 2 examined years- so in such a case the difference is due to different size of the companies. However, if the common odds ratio is different from 1, it means that the difference in the EMS criterion application detected in the basic test does really consist in the difference between the 2 examined years (2006 versus 2010), i.e. the difference is not due to the variability of company size.

However in this case the basic test as given above did not detect a statistically significant difference in the EMS criterion application. In addition, a common odds ratio has not been proved to exist by the homogeneity test. For these reasons, it does not make sense to pay attention to the repeated independence test for 2x2table in detail and its results are given only for methodological completeness (Fig. 5).

Fig 5 Criterion application – Stratification –Post-hoc tests

Source: own

Discussion and conclusions derived

The aim of the research was to determine whether it is advisable for logistic providers to implement and/or maintain an EMS in order to enhance their competitiveness, especially in time of intensified market pressure in macroeconomic instability.

The first task was to determine whether there exists data indicating that there has been a change (increase) in the number of business entities (companies) based in the Czech Republic, which - as a criterion in their provider selection process- consider the fact whether the potential provider has an EMS system implemented. For this purpose, a basic hypothesis was formulated assuming that the proportion of the EMS criterion application by the companies in 2006 was different from that in 2010. 366 companies (potential respondents) were selected and contacted with a request to provide the relevant data.

The assumption that the telephone form of data collection will bring about a high information yield of respondents was confirmed - the required data was provided (and external logistic services were used) by 293 companies (80.05% of the above number of potential respondents). This can be attributed to a lower degree of "depersonalization", which seems to be the main cause of the lower information return in the case of a classical questionnaire data collection.

The data obtained shows that in 2006, which means shortly before the crisis, 110 companies (37.54% of the total number of 293 respondents) applied the EMS criterion in their provider selection process. This value leads us to the

conclusion that - even before the crisis of 2008-2009 - the application of the EMS criterion was relatively common with the Czech companies and therefore it can be assumed that it could also have a significant weight in selecting the providers. In 2010, meaning shortly after the crisis culminated, this number even increased to 131 companies (44.71%), nevertheless this is only a small rise. A closer analysis of the structure of the detected differences shows that a change in the EMS criterion application occurred only in the case of a little more than half of the respondents, namely 161 companies (54.95%). It also ascertained that the number of the companies that started to apply the criterion in 2010 was only 21 (7.17%) higher than the number of the companies which ceased to apply the criterion (a change in the opposite direction). It is thus clear that the increase detected is only a small one, and the subsequent statistical analysis confirmed in an exact manner that it is not statistically significant. This verification was performed with a very reliable degree of reliability, where the differences detected in the EMS criterion application were assessed not only in terms of testing the difference (meaning subtraction) of the application proportions, but also in terms of testing the ratio of the proportions and the odds ratio of the proportions, in accordance with the principle of statistical multi-instrumentality (multiple statistical instruments application; asymptotic / exact). We can therefore state with high reliability that the proportion of the EMS criterion application - when compared between the period before the crisis and after the crisis - remained the same. This means that the approach of the companies towards EMS implemented with their potential providers did not change.

Very interesting ascertainties were acquired by means of the stratification analysis, at the beginning of which the original sample of the companies (ignoring the company size) was divided into 6 categories of company size depending on the number of employees. The results show that the highest proportion of EMS criterion application was detected in 2010 for companies with 50-99 employees, where 58.33% of companies applied the criterion, which is quite high if we consider the fact that the application proportion for all the companies as a whole (i.e. regardless their size and stratification) in 2010 was 44.71% as mentioned above. Another - and very surprising finding - is the fact that the highest application of the EMS criterion occurred in companies rather small (with a small number of employees) whereas the highest application proportion could have been expected for companies at the opposite end of the size range. This is because we can assume that "big" companies put more emphasis to "corporate culture" (of which environmental aspects are an integral part today) than small companies, for which the issue of public "image" is not so important.

Based on the stratification analysis, it was further ascertained that - on the contrary - the lowest application proportion was in 2006 in the case of the companies with 50-99 employees - only 25.00%, which is relatively small, considering that the application proportion for all the companies as a whole in 2006 was 37.54%, as mentioned above.

Recommendation 1: Based on the above ascertainment, we can encourage the logistic services providers to actively implement and/or maintain EMS. Since the EMS criterion is applied by almost half of the companies using external logistic services, it is to be expected that EMS can greatly increase the competitiveness of logistic providers and enhance their chances of being successful in the provider selection process carried out by their potential business customers.

Due to the fact that the lowest and highest proportions of the criterion application were detected in the same category of company size, it can be expected that companies of just this size (with this number of employees) also experienced the largest year-on-year (2006 versus 2010) change in the EMS criterion application - this assumption was confirmed by the value of the odds ratio ($\Psi_{CAT} = 4.2000$), which is the highest just in this stratum (company size category).

Although the year-on-year comparison in the basic test as specified above did not detect any statistically significant difference in the EMS criterion application, the stratification analysis also found out that a difference was nevertheless detected "within" 2 individual categories of company size, namely the companies with the employee count of between 50 - 99 [p-value: 0.0080] and with the employee count of between 150 - 199 [0.0131]. The full statistical significance of this difference is proved by the fact the values of the observed probability are highly convincing. Thus we can summarize that, although a statistically significant year-on-year (2006 versus 2010) difference was not detected in the original homogenous sample of 293 companies, a difference was detected only in the case of under-selection of companies with a certain number of employees. This is a manifestation of the so-called Simpson's paradox (effect),

where a certain statistical phenomenon (the difference of 2 proportions in this case) manifests itself only within (a) certain segment(s) (in 2 strata in this case) of the analyzed sample, but the difference disappears after merging these segments into a single whole (homogenous sample, ignoring the company size).

Recommendation 2: Although generally an economic crisis seems to have a negligible influence on EMS criterion application in logistic provider selection process, we can recommend that, at the time of macroeconomic instability, logistic providers should implement/maintain EMS in the case that their actual/potential business customers are companies with the employee count between 50 - 99, in which size category the most significant increase of EMS criterion application can be expected as a result of the macroeconomic competitive pressure.

However it should be borne in mind that these detected differences in the EMS criterion application may not have necessarily been caused by the economic crisis of 2008-2009, but by other, with the crisis coinciding, factors. This is because all the statistical tests carried out examined only whether there exists a statistically significant difference in the criterion application and, if so, how significant this difference is. However the causes of these changes (differences) could not be addressed by the tests themselves and speculation in this regard and considerations regarding related background are out of the focus and scope of this work. Yet, the differences identified in this way could suggest that the economic crisis of 2008-2009 could indeed - at least as a co-factor - lead to a different approach in this area, leastways in the case of the companies with the employee counts as specified above.

Also, it is necessary to realize that the failure to detect a statistical difference can perhaps be attributed to the fact that the respondents (in choosing their reaction to the questions presented) had a choice of only 2 extreme response alternatives (EMS criterion application: Yes / No). However, since it can be assumed that changes in internal organizational processes in real life do not happen by "leaps" but, on the contrary, in continuous (interconnected) stages, we can also assume that such a very "roughly" research scheme may not always be able to capture reality with sufficient sensitivity. Therefore, a follow-up research could be designed in such a way that it should be possible to analyze the uninterrupted process of continuous changes, for example the number of possible response alternatives could be increased by introducing the alternative of the partial EMS criterion application (No / Partially / Yes). However, such an approach would necessarily require a precise definition of the specific situation that corresponds to this additionally introduced response alternative (i.e. "partial" application) in real practice of the company. One of the most viable definitions appears to be the situation where the EMS criterion is applied but it is not critical in the provider selection process. This means that, although the EMS criterion taken into account, the potential provider's failure to comply with this criterion does not automatically disqualify him from the selection process. The introduction of this additional response alternative could therefore help to capture the minor nuances of the situation and thus also the eventual year-on-year differences in the application of the EMS criterion, even in the situations where these

differences could not be detected in a statistically significant manner with the application of only 2 response alternatives.

Despite the above limitations, the research can significantly contribute to a better theoretical understanding of macroeconomic instability influence on microeconomic environment and give logistic service providers practical guidelines on EMS policy with the view of strengthening their competitiveness, especially in time of economic turbulences.

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